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Is the pursuit of economic growth compatible with the pursuit of environmental sustainability? A discussion from the perspective of carbon emissions
Rubric: Neoclassical economics as a driver for development

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ABSTRACT
Neoclassical economics argues that environmental sustainability and economic growth in GDP terms are compatible through increased technological innovation and efficiency; however, exploring past data and observations as well as projections of future carbon emissions the increasingly prominent discpline of ecological economics brings significant evidence to suggest continued growth, which remains the paramount economic policy of most if not all nations, undermines sustainability.

1. INTRODUCTION

Growth and sustainability are commonplace terms in everyday language, often combined as 'sustainable growth' to denote a compatibility. But are these two terms as compatible as implied through day-to-day exchanges? Focusing on carbon emissions, this paper aims to discuss the question of whether or not economic growth is compatible with the pursuit of sustainability. The question is relevant to contemporary political, economic and social debates around the world, not least owing to recent and ongoing financial crises, climate change and poverty eradication, all of which transcend national borders.

There are two prominent schools of though, that of neoclassical and that of ecological economics. Neoclassical economics advocates compatibility, as growth is a catalyst for increasing technological efficiency, paving the way to decreasing emissions. On the other hand ecological economics challenges this view, based on soaring carbon emissions despite improved efficiency, urging for fundamental political, economic and societal changes and often calling for zero-growth or even degrowth. Analyses, projections, data and observations presented through the literature appear to be increasingly validating the view of ecological economists. This however does not necessarily imply that the changes advocated are forthcoming, not least due their proposed scale and marginalisation from mainstream political and economic reality. Research into public knowledge of and opinion towards a zero-growth or degrowth economy could provide initial indications towards the possibility, or at least public willingness (or lack thereof), of such alternatives.

Throughout this paper, sustainability is understood as the non-declining human welfare over time, whereby development "meets the needs of the present without comprising the ability of future generations to meet their own needs" such that intergenerational productive potential remains constant and successive generations can reach equal levels of human welfare (Pearce 1991). Economic growth is understood as the increase in real GDP or sometimes, real GDP per capita, usually from one year to the next (Victor 2010).

The methodology employed is a literature review covering material that spans the breadth of viewpoints regarding the compatibility of growth and sustainable development. Section two discusses some basic principles of decoupling. The third section further unpacks decoupling, relating it to carbon intensity and the arithmetic of growth. Section four examines growth in relation to the notion of limits and the proposed alternative of downshifting. Conclusions are then summarised in section five.

2. DECOUPLING: THE BASICS

2.1 Decoupling and Rebound Effects

Pearce (1991) argues that by altering the ratio of economic growth to environmental degradation the former can be decoupled from the latter, and employing market-based approaches such as cap-and-trade schemes will render decoupling successful. Kallis (2011) discards such schemes as ineffective profit-driven tools with light regulation. Indeed the European Union Emissions Trading Scheme (EU ETS) attracts criticisms including the initial setting of a loose cap (higher than actual emissions) as well as initial exemption of international shipping and aviation. Although neither of these measures presents incentives for decoupling it can be argued that in the longer term the ETS will achieve its aims as the cap is tightened and aviation and shipping are included. However, as Pearce (1991) does not distinguish between relative and absolute decoupling (discussed later), the important question of whether the former or the latter would be achieved remains, although it should be noted that Pearce's account dates back to 1991 when research on decoupling was not as comprehensive.

One of the main drawbacks of decoupling is the 'rebound effect' whereby e.g. cheaper prices or decreased carbon intensity per unit GDP have fuelled increased consumption and production as well as energy demand (Sorrell 2010). Rebound effects can be both direct and indirect, and one is not dependent on the other. As efficiency improvements reduce the marginal cost of energy services, such services may experience increased consumption; known as the direct rebound effect (Sorrell 2010). The indirect rebound effect results when resources that were normally invested for one purpose are invested for a different one that may also involve energy intensity for production, often prompting consumption of more energy-intensive goods and services (Sorrell 2010). One of the consequences of the rebound effect, both direct and indirect, is increased carbon emissions. Sorrell (2010) concludes that the potential for decoupling carbon emissions from economic growth is limited due to the fact that rebound effects render energy efficiency less effective in reducing overall energy consumption than is often assumed.

2.2 Environmental Kuznets Curve

Lomborg (2001) notes the dramatically decreasing air pollution in developed countries, highlighting that this has occurred simultaneously with economic growth. This implies decoupling is possible, however analysis is not carried out with regards to CO_2, rather focusing on other substances including sulfur dioxide (SO_2) and particulates. Lomborg's argumentation can follow from neoclassical economics in line with the suggestion that efficiency improvements are yielded by economic growth. Evidence does indeed exist from specific substances including SO_2 and particulates that have demonstrated an inverted-U shape relationship with economic growth, known as the Kuznets curve. This relation sees original increase in emissions and hence environmental damage at early growth stages followed by a peak during economic expansion, and decline with further growth (Jackson 2009). While the relationship holds for certain local environmental problems including urban air and water quality, it does not exist for carbon emissions (Victor 2010). Figure 1 demonstrates the relationship for different environmental aspects (Azar et al. 2002). As can be seen, urban SO_2 concentrations follow the traditional Kuznets relation whereas CO_2 emissions do not, with emissions per capita increasing as per capita income also increases.

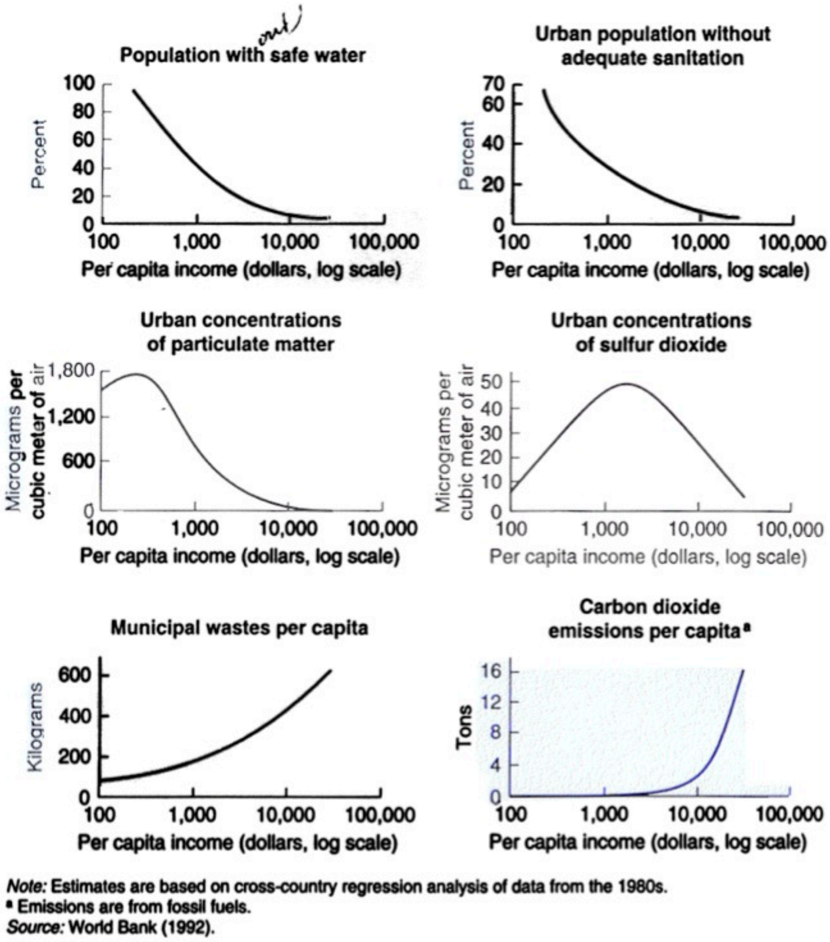


Figure 1: *Environment and economic development (Azar et al. 2002)*

After comprehensive view of data and methodology used in estimating environmental Kuznets curves, Stern (2004) concludes, "…the statistical analysis on which the curve is based is not robust. There is little evidence for a common inverted U-shaped pathway that countries follow as their income rises." Furthermore, policies and measures were put in place to achieve such air pollution reductions, they were not merely a side effect of economic growth as some suggest (Azar et al. 2002). As Azar et al. (2002) note, it is a common fallacy that progress is being made based on emissions reductions of specific compounds in relation to GDP. Furthermore, it is aggregate emissions that should be the focus as GDP grows faster than intensity declines (Azar et al. 2002).

3. DECOUPLING, GROWTH ARITHMETIC & INTENSITY

3.1 Absolute and relative decoupling

It is important to distinguish between relative and absolute decoupling. Relative decoupling signifies a decline in ecological intensity per unit of economic output, such as decreasing CO_2 emissions per unit of GDP. As a result, and as previously mentioned, emissions decline relative to GDP, not necessarily in absolute (or aggregate) terms, therefore environmental impacts may increase but at a slower rate than GDP growth. Absolute decoupling would result in emissions declining in absolute terms, either leveling off or declining altogether with increasing GDP and growth.

As global energy intensity is currently 33% less than in 1970 and overall intensities have declined across OECD countries in the last three decades, relative decoupling has indeed been achieved (Jackson 2009). Declining carbon intensities are illustrated in Figure 2.

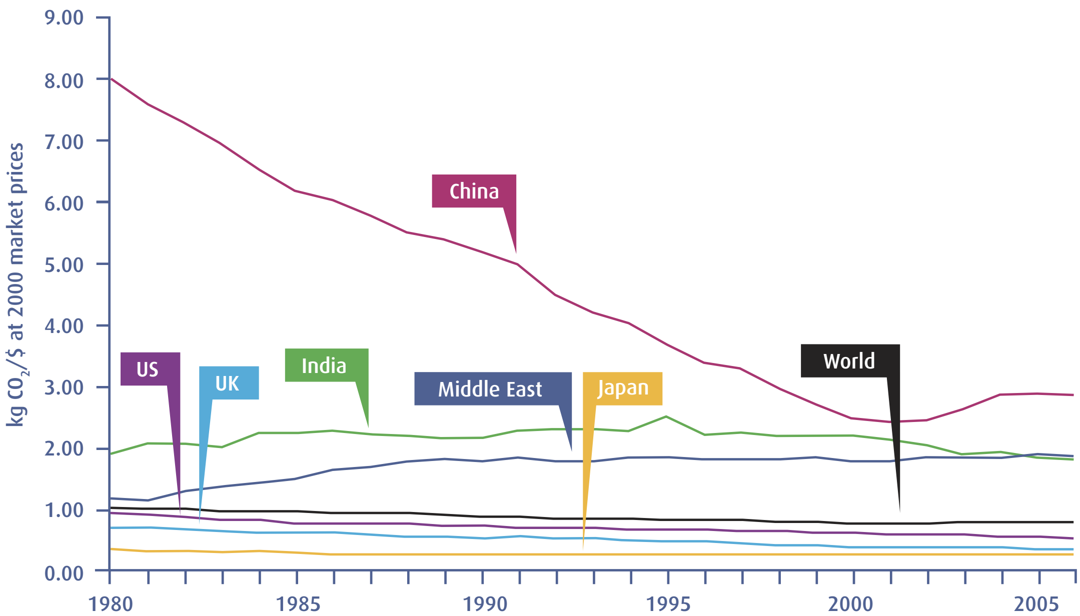


Figure 2: *CO_2 intensity of GDP across nations: 1980-2006*
(IEA 2008, Jackson 2009)

For decoupling to reach its aims, resource efficiencies must increase at least as fast as economic output and continue to improve as the economy grows, (Jackson 2009). This points towards the need for absolute decoupling. However, CO_2 emissions from fossil fuels have increased by 80% since 1970 despite declining energy and carbon intensities, while increased coal consumption since 2000 has increased the growth rate of emissions (Jackson 2009). Figure 3 shows that relative decoupling has been achieved as GDP increased faster than CO_2 emissions from 1980 to 2006, but absolute decoupling is not observed.

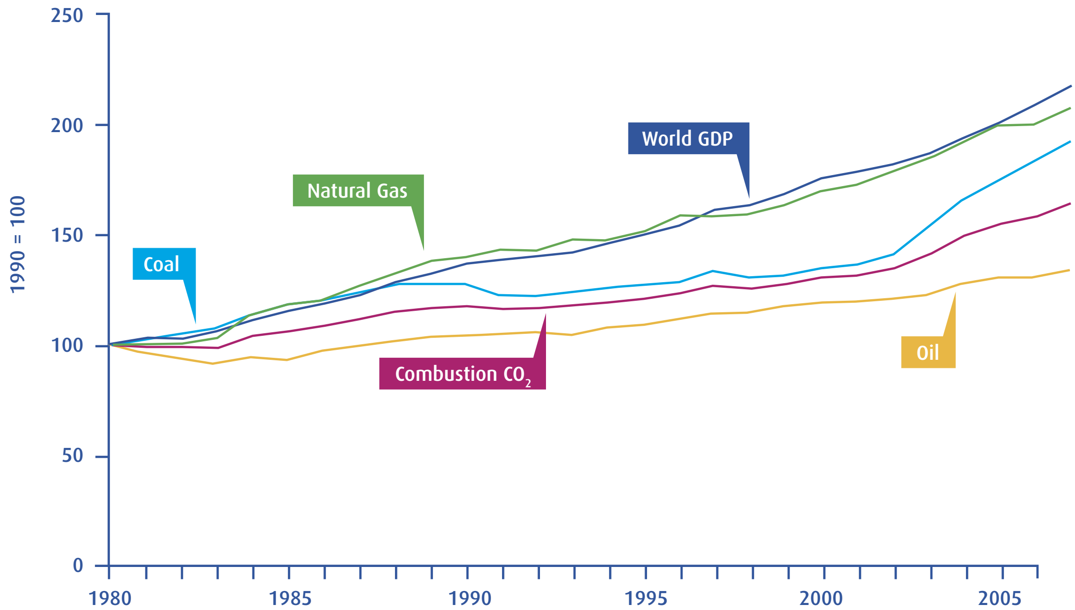


Figure 3: *Trends in fossil fuel consumption and related CO_2: 1980-2006 (IEA 2008, Jackson 2009)*

It is noteworthy that current data underestimate the resource requirements of developed economies due to 'hidden' outsourced manufacturing to developing countries that is not necessarily accounted for, thus failing to reveal true values (Jackson 2009, Sorrell 2010). For example, official figures indicated a 5% reduction in UK carbon emissions from 1990 to 2004; this figure changes to a 15% increase when emissions from international trade are accounted for (Sorrell 2010). Official European Union statics suggest a decoupling of approximately 16% between 2000 and 2007 (Kemper 2010). This figure however does not include emissions from international trade, shipping and aviation, producing a skewed result. Not only is absolute decoupling of economic growth from carbon emissions therefore far from reality, even the relative decoupling observed in recent decades (Figure 3) is exaggerated.

3.2 Arithmetic of Growth

The Ehrlich equation governs the relationship between relative and absolute decoupling (Jackson 2009).

$$I = P \times A \times T$$

I represents total environmental impact, *P* is population, *A* equals affluence or income level and *T* denotes technological performance or efficiency. Applying the equation to carbon emissions, *I* represents total CO_2 emissions, *A* is GDP per capita, *T* equals carbon emissions per unit GDP and *P* again denotes population.

As *T* decreases, relative decoupling is achieved, however to reach absolute decoupling *I* must also decrease. This can only be satisfied if *T* decreases more rapidly than the pace at which *P* and *A* increase, combined. This also holds for future prospects of decoupling emissions from growth. With substantially increasing affluence *A* and population *P* over the past five decades this requirement has been and will continue to be difficult to satisfy, although some consider that rapid technological efficiency increases may render absolute decoupling possible (Jackson 2009). The conditions required to achieve this are historically unprecedented (Jackson 2009, Sorrell 2010). The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) suggests that to reach 450ppm, global CO_2 emissions must not exceed 4bn tonnes/year by approximately 2050 (Solomon et al. 2007). This would require reducing annual emissions to an average of 4.9% from now until 2050, a situation that is indeed highly unlikely with increasing income and global population (Jackson 2009). Under business as usual, the UN estimates that carbon intensity just about balances population growth, with CO_2 emissions forecast to grow at a rate equivalent to that of average income, i.e. 1.4% annually, which would lead to emissions 80% higher than at present (Jackson 2009). Set against current carbon intensities, Figure 4 illustrates estimates of the intensities required to meet the 450ppm UN target (IEA 2008).

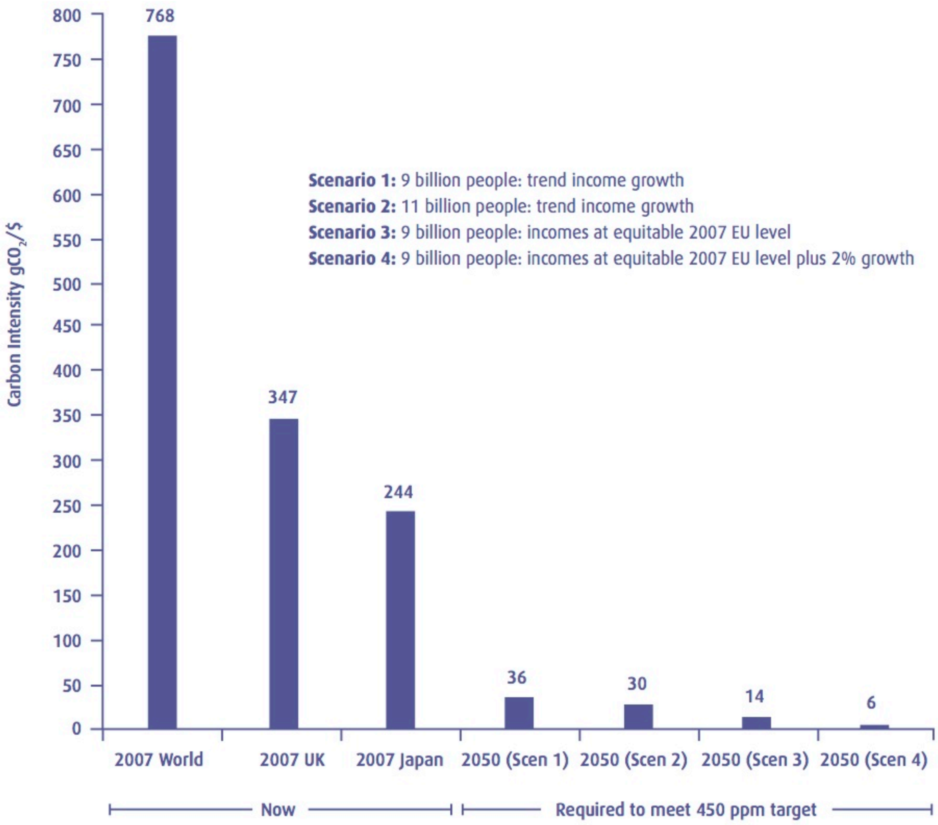


Figure 4: *Carbon intensities now and required to meet 450ppm target (IEA 2008, Jackson 2009)*

Notwithstanding the above projections, Ekins (2000) argues that current policies "barely scratch the surface" of measures that could be taken to deliver decoupling. Although the lack of intense efforts is cited as a possible reason for failing to decouple energy consumption and emissions from growth, greater emphasis is placed on the role of the rebound effect previously discussed (Sorrell 2010). In fact, the required changes in carbon intensity are even more challenging when rebound effects are considered (Sorrell, 2010). In line with Figure 4 Sorrell (2010) therefore concludes that unless implausibly large improvements in energy and resource efficiency are realised, further economic growth is unsustainable over the long term.

3.3 Intenisty

Victor (2010) studied the rate of economic growth in relation to greenhouse gas emissions reductions, investigating whether faster growth leads to greater reductions. Higher growth rates in the US from 1976 to 2004 were associated with slower rather than faster reductions in intensity, or CO_2 per unit GDP (Victor 2010). More broadly, between 1966 and 2005 slower rates of economic growth saw greater reductions in CO_2 and energy intensity in high-income countries (Victor 2010). The data therefore denies the claim that higher rates of economic growth are required to achieve faster rates of reductions in CO_2 intensity (Victor 2010). While it is not implied that lower growth rates universally lead to a faster reduction in CO_2 intensity the argument does challenge the orthodox assumption that more, faster growth holds the key to intensity and CO_2 reductions through improved technological efficiency. Incorporating the principle of aggregate consumption and emissions, Ayres (2005) claims, "…efficiency improvements have rarely, if ever, resulted in reduced aggregate energy consumption." Haberl et al. (2006) claim that increased consumption and increased aggregate emissions more than compensate for increases in efficiency.

Table 1 shows estimates of the relationship between reductions in intensity and rate of economic growth needed to meet specific reductions in environmental impact (Victor 2010). Higher growth requires higher intensity reductions (for example to achieve a 70% target of environmental degradation reduction in an economy with 3% growth, an intensity reduction of 91% will be required). Based on the evidence that faster growth rates often lead to lower intensity reduction rates, achieving sustainability through faster growth appears to be a contradiction.

		Rate of economic growth				
		0%	1%	2%	3%	4%
Reduction in environmental impact in 40 years	50%	50%	66%	77%	85%	90%
	60%	60%	73%	82%	88%	92%
	70%	70%	80%	86%	91%	94%
	80%	80%	87%	91%	94%	96%
	90%	90%	93%	95%	97%	98%

Table 1: Economic growth, intensity and environmental impact reduction (Victor 2010)

4. GROWTH: LIMITS AND DOWNSCALING

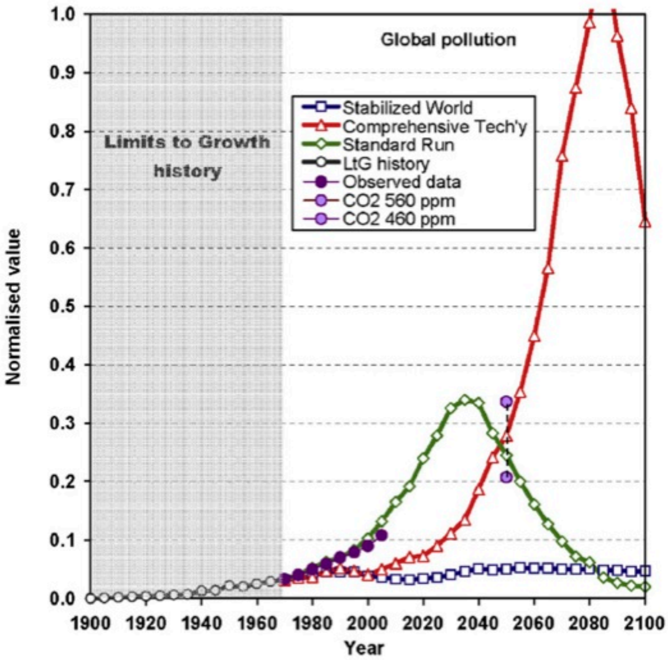
The current growth imperative and the fact that growth is a key economic policy objective is no secret It is evident across the developed world, not least through the ongoing financial crisis where the ultimate, non-negotiable goal is restoration of growth (Jackson 2009). But the relevance and feasibility of perpetual growth are being brought into question. Ecological limits are increasingly pronounced while growth and increased GDP prove to be unreflective indicators for a fair, healthy and mature society.

4.1 Limits to Growth

In *Limits to Growth* (LtG) Meadows et al. (1972) used an integrated global model based on trends from 1900 to 1970 to link the world economy with the environment, putting forward the idea that planetary limits are likely to be exceeded during the 21st century under continued growth or a business as usual scenario. Overshoot and collapse of the global system was predicted, though deemed avoidable through technological and policy changes (Meadows et al. 1972).

Using three key scenario runs, LtG included projections of population, birth and death rates, food per capita, industrial output per capita and non-renewable resources for the period from 1900 to 2100.

The first run was the 'standard run' under which business as usual is assumed. The second and third runs, 'comprehensive technology' and 'stabilized word', respectively, are successively more optimistic. The second run employs purely technological solutions to achieve sustainability while the third run combines technological solutions with deliberate social policies to achieve equilibrium states for key factors including population, material wealth and food for capita (Turner 2008).



Comparison of observed data (solid circles ●) for global persistent pollution with the LtG model output for each scenario ("standard run" with open diamonds ◇, "comprehensive technology" with open triangles △, and "stabilized world" with open squares □). The calibrated model output over 1900–1970 is shown with open cirlces ○. Separate points at 2050 show IPCC estimates of possible upper and lower CO_2 levels at 2050 (from A1F1 and B2 scenarios), corresponding to 560 and 460 ppm, respectively.

Figure 5: *Observed data against LtG projections (Turner 2008)*

By comparing the projections from Meadows et al. (1972) to scientific data and historical observations from 1970 to 2000, Turner (2008) illustrates that historical data most closely matches the simulated results of the 'standard run' scenario for nearly all outputs and variables.

LtG modeled levels of persistent pollution using atmospheric greenhouse gases and in particular CO_2, relative to 1900 levels. Figure 5 displays the result produced by Turner when comparing projection and observation. Even in the context of carbon emissions, the 'standard run' scenario offers the best correlation.

Turner's contribution is significant. Without explicitly referencing ecological or neoclassical economics but rather comparing projections against observations he proves the initial LtG projections as correct (to a large degree, at least), thus implicitly proving that continued economic growth is incompatible with the pursuit of sustainability, at least to the extent in which it has (or has not) been pursued to date. Turner (2008) points out that uncertainty regarding the relationship between pollution levels and ecological impacts is diminishing, further reinforcing the concept of incompatibility.

While the 'standard run' best fits reality, the 'comprehensive technology' and to a greater extent the 'stabilised world' runs contain elements of what ecological economics suggests, including the preference for consumption of services and health facilities as oppose to material goods. The analysis of Meadows et al. (1972) suggests that key steps which could have been taken towards sustainability, or perhaps even towards stabilisation and zero-growth, were not taken. Although attributing non-implementation of such measures to specific causes may prove difficult, in hindsight it is not unreasonable to assume that the key economic policy goal of growth shared by the overwhelming majority of developed nations favoured growth and hindered sustainability, failing to combine the two. By testing projection against reality Turner's (2008) account provides some of the most compelling and robust evidence available that the pursuit of sustainability is in fact incompatible with economic growth.

LtG provoked many criticisms that often falsely claim resource depletion and collapse were predicted by the end of the 20th century (Turner 2008). Such criticisms combined with current availability of resources may explain why the work by Meadows et al. and Turner's paper are not highly prominent in mainstream public discourse on growth and sustainability.

4.2 Zero-growth & degrowth

Although the focus of this paper is to examine the compatibility of economic growth with the pursuit of sustainability in the context of carbon emissions, it is not entirely beyond reason to ask the question *what next?* This question is particularly relevant provided it arises naturally in the ecological economics literature, which challenges orthodox theory by suggesting that growth and sustainability are incompatible, often advocating satbilisation or reduction in growth as an alternative.

Degrowth, or downshifting, is defined from an ecological economics perspective as a socially sustainable and equitable reduction (and stabilisation) in society's throughput, where throughput denotes the materials and energy a society extracts, processes, transports and distributes, to consume and return back to the environment as waste (Kallis 2011). Pearce (1991) suggests that such growth policies in developed countries will not solve environmental degradation, as they would lead to a decreased material standard of living for the average citizen in rich countries, when combined with resource transfers to developing countries. Banning certain economic activity and forbidding use of certain resources is not seen as a solution; instead policies should be designed to address the causes of environmental degradation (Pearce 1991). The past decade however has seen increasing volumes of literature on the subject of zero growth or degrowth. While sidelined by the mainstream as overly vague and radical to be relevant or feasible (Kallis 2011), such concepts are increasingly established and debated in academic discourse.

Arguably however, the 'solution' of downshifting raises more questions than it answers, as environmental and ecological economists themselves recognise. Sorrell (2010) comments that a zero-growth economy is incompatible with current financial systems and institutions.

Modern societies are structured on a growth imperative requiring increased consumption. It therefore follows that transition to such an economy is not likely to be achieved without fundamental reforms to political and financial institutions (Sorrell 2010). Kallis (2011) and Victor (2010) raise a host of valid questions ranging from the role of money in a downshifted economy to the institutions required to limit throughput and protect the environment.

Possibly as many proposals on policies to adopt in a downshifted economy exist as do questions on what such a society would look like. These include reduced working hours and a 21-hour working week, minimum income as well as salary caps and institutions guaranteeing minimum health and economic security to all (Kallis 2011). An essential starting point is therefore to set out a coherent notion of sustainability that doesn't rely on preconceived ideas about growth.

5. CONCLUSIONS

This paper discussed the compatibility of sustainability and economic growth from the perspective of carbon emissions by reviewing neoclassical and ecological economic approaches available in the literature. While the neoclassical view supports the idea of compatibility through decoupling of economic growth and carbon emissions, driven by increased efficiency, the ecological view demonstrates this is essentially implausible, using current projections as well as past data and observations to support the argumentation. In short, past, present and future projections of carbon emissions suggest that economic growth is not compatible with the pursuit of sustainability, unless political, financial and social systems are overhauled. Such colossal changes are currently beyond the realm of public discourse, as GDP growth remains the paramount economic policy of most developed nations, with little signs of change ahead.

Some neoclassical economists who don't doubt the desirability of economic growth do question its long-term feasibility due to environmental constraints. Perhaps the penny is beginning to drop. The ecological view is increasingly prominent, however public opinion regarding potential alternatives is unknown; research into this has the potential to influence public debate.

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